



The investigation of Precipitation Concentration Index in West Azerbaijan (Iran) weather stations

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General Note

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ABSTRACT

Different aspects of rainfall phenomenon, as one of the important meteorological factors that directly affects access to water resources, is very important. Due to significant impacts of rainfall on water resources such as groundwater, surface water, and snow reservoir, it seems to use indices to explain its changes. Precipitation Concentration Index (PCI) is proposed as an indicator of concentration and distribution of rainfall on annual and seasonal scale. In this study, rainfall data of 66 rain gauges stations at West Azerbaijan province (Iran) during 1993-2010 were evaluated to investigate PCI index. The results showed that the connection index is in the range of 12-22, accordingly, the distribution of rainfall in 79% of stations is relatively seasonal, 20% of stations is seasonal and only one station has the quite seasonal distribution of rainfall. Spatial distribution pattern of PCI index showed that rainfall pattern in the northern parts of the province is relatively seasonal and with the move to South changes to the seasonal pattern.

Keywords: kriging, Precipitation Concentration Index, rain gage station, rainfall pattern

1. INTRODUCTION

Climate change in the current era is one of the most important environmental challenges. Precipitation is one of the most important climate elements directly affecting the availability of water resources (Randall et al., 2007). Low amount of precipitation and its extreme fluctuations in the daily, seasonal and annual scales is an inherent characteristic of Iran's climate (Khalili et al. 2015). Due to significant impacts of rainfall on water resources such as groundwater, surface water, and snow reservoir, it seems to use indices to explain its changes. Among these factors can be cited to Standard Precipitation Index (SPI) and Precipitation Concentration Index (PCI). SPI index including applicable indices that are used in most studies, while PCI index has been introduced in recent years (Khalili et al. 2015). To assess the density of precipitation Different indices have been used and among these the Precipitation Concentration Index (PCI) (Oliver, 1980) is recommended, because it provides information on long-term total variability in the amount of rainfall received (Michiels et al., 1992; Apaydin et al., 2006; De Luis et al., 2010).

Precipitation Concentration Index (PCI) is a strong indicator of time distribution of rain that commonly used in the annual scales (Vali et al, 2013). Increasing the amount of this factor, which means that rainfall has a large concentration in the region. In addition, PCI along with Fournier index is part of CORINE's erosivity index that is considered as a powerful method for assessing the risk of erosion (Luis et al, 2011). Results obtained from PCI can be used as a warning tool for preparedness in the face of flood and erosion for hydrologic management, environmental and water resources programs (Adegun et al. 2012). Also, this concept can be used in irrigation planning and design of new systems. Unbalanced distribution of rainfall can reduce crop yields by reducing the stored moisture in the ground and increase the number of periods to be irrigated. In addition to, the unbalanced distribution of rainfall that means drought and rainfall lower than the average rainfall of region is causing dangerous floods because soil moisture is decreased and as a result, vegetation cover is destroyed. Finally, it will increase the protective measures in the basin in order to maintain water structures (Vali et al, 2013). Khalili et al (2015) using monthly precipitation data from 34 Iran's border synoptic station at period 1961-2011 were calculated Precipitation Concentration Index and evaluated its trends in annual and seasonal scales. Zonation results of the index in annual scale showed the dispersion of rainfall on two sub-interval of 25 years follows the same pattern. Based on results, PCI index in the central and southern regions of the country, includes Kerman, Bandar-Abbas, Yazd, Zahedan, Shahrekord, Birjand, Bushehr, Ahwaz and Isfahan showing a lot a disorder and high dispersion in the atmospheric fallout and in any of studied stations, there was no focus uniforms ($PCI < 10$) in annual terms.

Luis et al (2011) were studied the average amount of annual, seasonal, and wet and dry sub-interval of Precipitation Concentration Index for two period of 1964- 1975 and 1976-2005 in the vicinity of Spain. Analysis of two sub period revealed significant changes in occurred rainfall from 1964 to 2005 in Spain.

Vali et al (2013) Used PCI index for rainfall patterns in the state of Andhra India for the period 1981-2010 in both annual and quarterly level. The results from this index showed irregular distribution of rainfall with values ranging from 16 to 35. The aim of this study, given the importance and role of rain in the development of management programs, is the investigation of Precipitation Concentration Index at West Azerbaijan (Iran).

2. MATERIAL AND METHODS

Area of study

West Azerbaijan province with an area of 37210 square kilometers (including the Urmia Lake) is the thirstiness province of Iran in extent and is located at a geographic location of 44° 3' to 47° 23' East longitude and 35° 58' to 39° 34' Northern latitude. In this study, in order to investigate of Precipitation Concentration Index, rainfall data from gauge stations of West Azerbaijan (Iran) were used. Referring to the Iran water resources management, information, including daily rainfall data, the geographical coordinates of the stations and years of statistics, received. After reviewing, Stations with incomplete data were excluded and finally, 66 rain gauge stations were selected. Information on daily rainfall for a period of 20 years (1993-2012) reviewed in terms of homogeneity and normality using Kolmogorov-Smirnov test and was used for calculating of PCI index. Figure 1 shows position of the region as well as the location of stations.

PCI index

PCI index is used as an indicator for identifying the temporal distribution of rainfall during the year. This index provides possibility to classify rainfall data based on seasonal or not. PCI index in annual term is calculated from the below equation.

$$PCI = \frac{\sum_{i=1}^{12} p_i^2}{p^2} \times 100 \quad (1-1)$$

P_i = amount of rainfall in month I , and P = yearly total of rainfall.

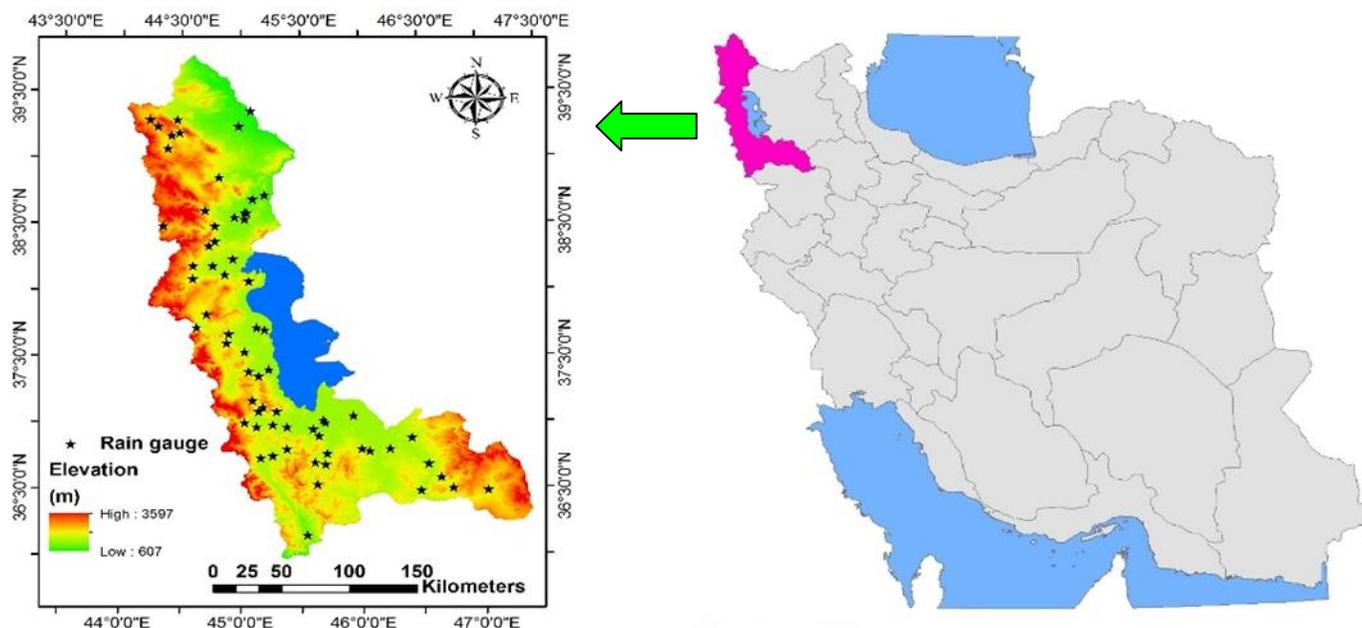


Figure 1 Position of the region and the location of stations

Oliver (1980) provides a classification for values of PCI that according to which values less than 10 are indicators of uniform distribution, values between 11-15 represent relatively seasonal distribution of rainfall, Values between 16-20 represent a seasonal distribution, and values over 20 indicate highly seasonal distribution of rainfall. Also, in order to the investigation of the possibility of temporal changes in the uniformity of precipitation, time period divided into two 10 years part, includes first decade (1993-2002) and the second decade (2003-2012) and in each of these periods, Precipitation Concentration Index was calculated separately. Finally, Precipitation Concentration Index data convert to area information (map) using simple kriging method.

3. RESULTS AND DISCUSSION

Descriptive statistics of the rainfall data is presented in the table (Khalili et al, 2015). Average rainfall in the entire the area at 20 years period is approximately 325 mm. The mean value of PCI was 16.66 that indicate the seasonal distribution of rainfall in the province. The minimum value of PCI for the area was 12.36 that indicate the fair distribution of rainfall and the maximum value of this index for the entire period was 22.17 that represents the distribution of rainfall is very seasonal. The important note is little differences in statistics related to Precipitation Concentration Index so that during the period of two decades, mean changes of PCI is less than 2%.

Table 1 Descriptive statistics of precipitation parameters on the studied period

statistics	Yearly rainfall (mm)			Precipitation Concentration Index		
	Entire period	First decade	Second decade	Entire period	First decade	Second decade
Mean	324.95	311.44	388.45	16.66	16.45	16.88
Maximum	659.55	654.67	664.42	22.17	20.24	24.14
Minimum	172.59	155.35	177.88	12.36	12.35	12.38
Coefficient of variation (%)	26.45	28.69	26.35	10.54	9.84	13.60

Frequency distribution of PCI values on the surveyed stations (Fig.2) shows on 20% of stations, Precipitation Concentration Index is relatively seasonal, on 79% of station, PCI is seasonal and only at one station, PCI is over 20 (Yalgooz-Agach station at north of province) that presents rainfall distribution in that region is quite seasonal.

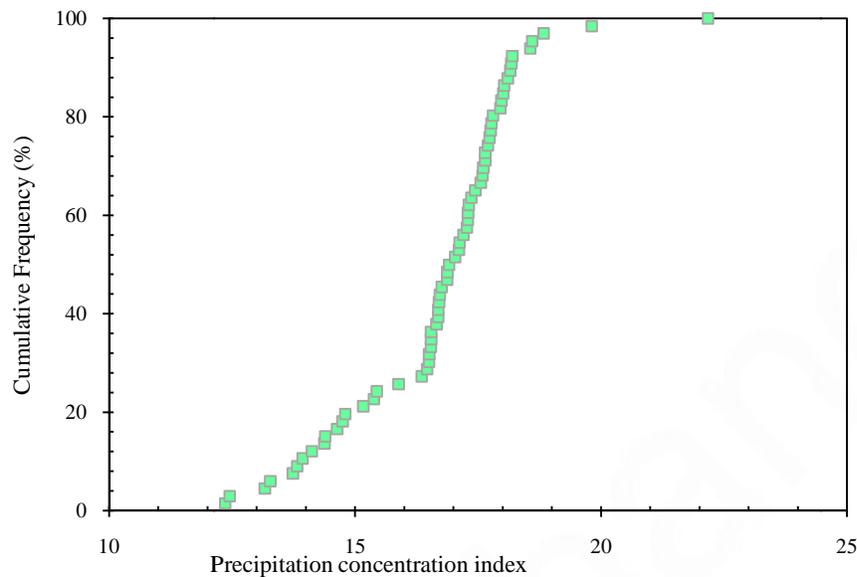


Figure 2 The cumulative frequency distribution of Precipitation Concentration Index

Figure (3) shows that in all stations of province, with seasonal, relatively seasonal and quite seasonal of rainfall distribution, the largest and lowest amount of rainfall is in April and August, Respectively.

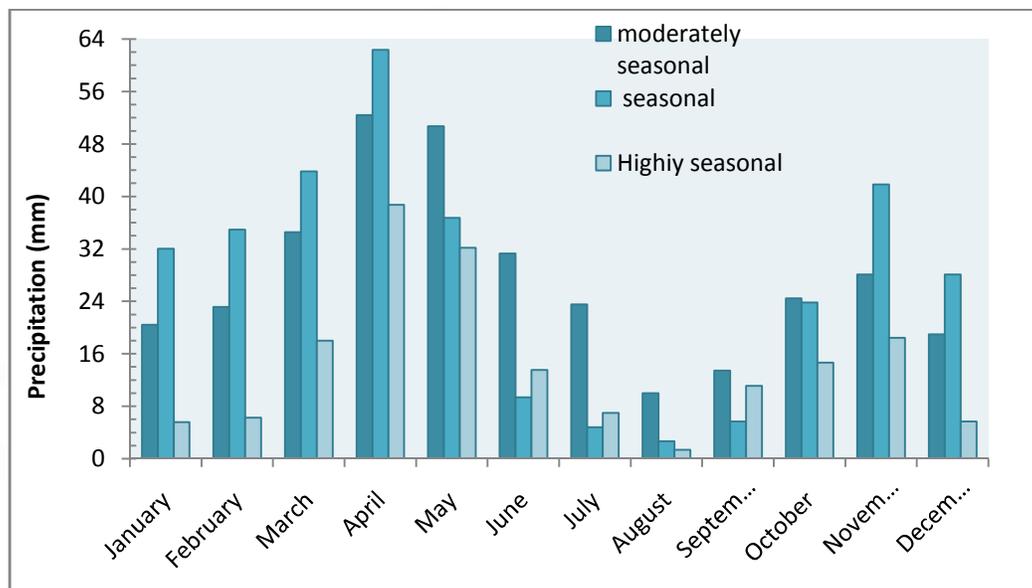


Figure 3 Mean of rainfall amount at stations with different seasonal distribution.

According to Oliver classification For PCI and results obtained by Kriging interpolation map, 10559.686 Km² of province area has a relatively seasonal pattern and 26650.775 km² has a seasonal distribution of rainfall. Also, the spatial distribution of rainfall (Fig.4) shows in the northern of the province, the rainfall pattern of rainfall is relatively seasonal, while southern region shows seasonal pattern of rainfall. Generally, distribution pattern of PCI reflect the fact that rainfall distribution on area is relatively seasonal or seasonal, that means distribution of rainfall on province is irregular and total rainfall is concentrated on ½ of time period. This is very

important in terms of soil conservation management and watershed management issues, because by considering this pattern and determining seasons with maximum erosivity, to be the more precise management of watersheds.

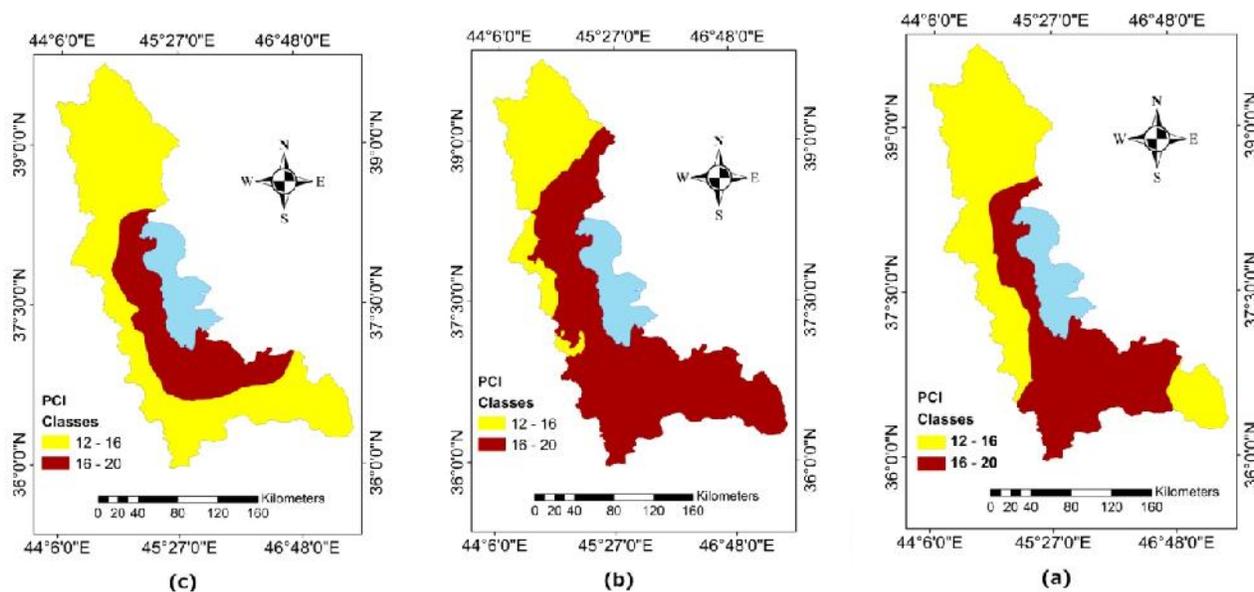


Figure 4

Spatiotemporal precipitation concentration index (%) distribution in the West Azerbaijan province (Iran). (a) Precipitation concentration index, 20-year, (b) precipitation concentration index, the first decade, (c) precipitation concentration index, the second decade.

The relationship between precipitation and geographic concentration index of points

To investigate the relationship between the values of the precipitation concentration index and the position of the stations, the correlation between these variables with latitude and longitude and elevation of stations was determined that the results are provided in table (2). This table clearly shows that latitude compared to the length and height of the stations has the highest correlation with the precipitation concentration index. Also, elevation has positively correlation with the precipitation concentration index. Given the strong correlation between latitude and the parameters of the study, the linear relationship of this variable with latitude is provided in Figure (5).

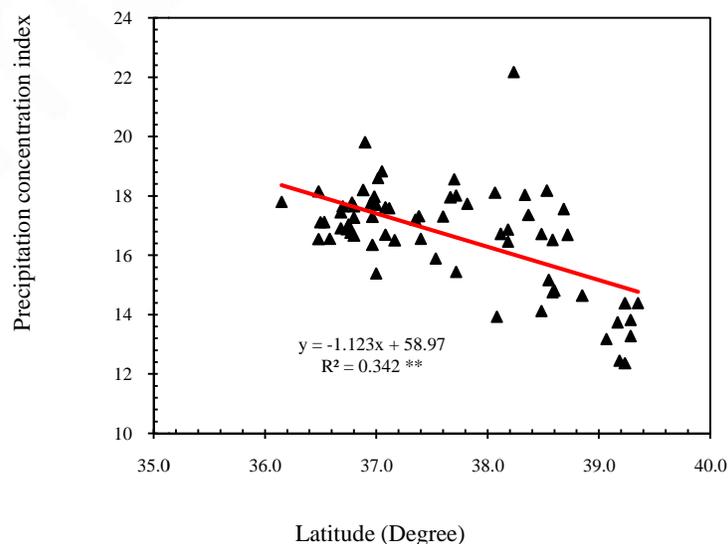


Figure 5 Relationship between PCI with latitude

Table 2 Relationship between PCI with geographical features of points

Elevation	latitude	Longitude	PCI
0.285**	0.558**	0.473**	Total period
0.336**	0.549**	0.457**	First decade
0.170**	**0.572**	0.444**	Second decade

Relations presented in Figure (4-5) clearly reflect that latitude can explain changes related to this index. At lower latitudes that are related to forest areas, seasonal conditions of rainfall is less visible, while with the move to higher latitude to the north of the province, The precipitation becomes more seasonal conditions.

REFERENCE

- Adegun, O., Balogun, I., and Adeaga, O. 2012. Precipitation concentration changes in Owerri and Enugu. Special Publication of the Nigerian Association of Hydrological Sciences, pp. 383-391.
- Apaydin, H., Erpul, G., Bayramin, I., and Gabriels, D. 2006. Evaluation of indices for characterizing the distribution and concentration of precipitation: A case for the region of Southeastern Anatolia Project, Turkey, *J. Hydrol.*, 328: 726–732.
- De Luis, M., Gonzalez-Hidalgo, J. C., and Longares L. A. 2010. Is rainfall erosivity increasing in the Mediterranean Iberian Peninsula? *Land Degrad. Dev.*, 21, 139–144.
- Khalili, K, Nazeri Tahrudi, M, Mirabbasi, R and Ahmadi, F. 2015. Investigation of spatial and temporal variability of precipitation in Iran over the last half century. *Journal of Water and Soil*, 30(4), pp. 1309-1321.
- Luis, M., Gonzalez-Hidalgo, J.C., Brunetti, M., and Longares, L.A. 2011. Precipitation concentration changes in Spain 1946–2005. *Natural Hazards Earth Systems Science*, 11: 1259–1265.
- Michiels, P., Gabriels, D., and Hartmann, R. 1980. Using the seasonal and temporal precipitation concentration index for characterizing monthly rainfall distribution in Spain, *Catena*, 19, 43–58.
- Oliver, J.E. 1980. Monthly precipitation distribution: a comparative index. *The Professional Geographer*, 32(3): 300-309.
- Randall, D. A., Wood, R. A., Bony, S., Colman, R., Fichet, T., Fyfe, J., Kattsov, V., Pitman, A., Shukla, J., Srinivasan, J., Stouffer, R.J., Sumi, A., and Taylor, K. E. 2007. *Climate Models and Their Evaluation, Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge University Press. Cambridge, United Kingdom and New York, NY, USA.
- Vali, M., Shanti Sree, K., and Iyyanki, V.M.K. 2013. Analysis of precipitation concentration index and rainfall prediction in various agro-climatic zones of Andhra Pradesh, India. *International research journal of environment Sciences*, 2(5): 53- 61.